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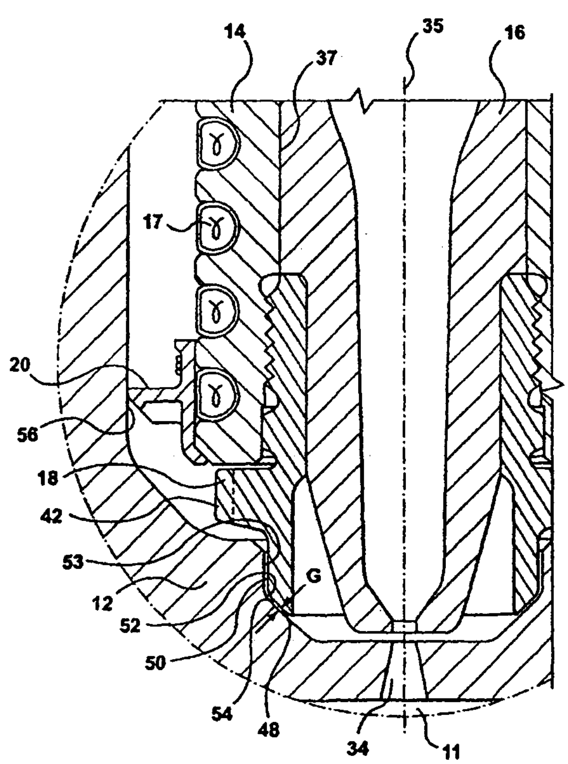
(54) Title: GAP SEAL BETWEEN A NOZZLE AND A MOLD COMPONENT IN A HOT-RUNNER ASSEMBLY FOR AN INJECTION MOLDING APPARATUS



(57) Abstract: A nozzle for an injection molding apparatus is provided. The nozzle includes a nozzle body, a heater and a first gap seal surface. The nozzle body defines a nozzle body melt passage, that is adapted to be downstream from and in fluid communication with a melt source, and upstream from and in fluid communication with a gate into a mold cavity in a mold component. The heater is thermally connected to the nozzle body for heating melt in the nozzle body melt passage. The first gap seal surface is positioned on a structure that is connected at least indirectly to the nozzle body. The first gap seal surface is adapted to be separated by a gap with respect to a second gap seal surface on the mold component. The gap is sized to inhibit the flow of melt between the first gap seal surface and the second gap seal surface.

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Title: GAP SEAL BETWEEN A NOZZLE AND A MOLD COMPONENT IN AN INJECTION MOLDING APPARATUS

FIELD OF THE INVENTION

This invention relates to an injection molding apparatus, and more particularly to a seal between a nozzle and a mold component in an injection molding apparatus.

BACKGROUND OF THE INVENTION

A hot runner injection molding apparatus typically includes nozzles that are heated to maintain melt therein at a controlled temperature. The nozzles are typically in contact with a mold component that defines one or more mold cavities. The mold cavities in the mold component are filled with melt that first passes through the nozzles. The mold component is then typically cooled in order to solidify the melt in the mold cavities, thus forming a plurality of molded parts, which are then ejected from the mold cavities.

Because the nozzles are typically heated, and the mold component is cooled for at least a portion of an injection molding cycle, it is desirable to have a relatively low heat transfer from the nozzles into the mold component. Many nozzle constructions have been proposed in the past to address this issue.

An example of such a nozzle construction is shown in US Patent No. 5,554,395, to Hume et al. The '395 patent teaches a multi-piece nozzle tip assembly including a tip piece, a tip surrounding piece and a resilient element. The resilient element is provided between the tip piece and the mold component, to inhibit melt leakage therepast. However, heat can be lost from the tip piece through the resilient element and into the mold component. In particular, the heat losses occur near the downstream end of the tip piece, where control over the temperature of the melt is particularly important.

Thus, there is a continuing need for new nozzle constructions that have further improved heat transfer efficiency.

SUMMARY OF THE INVENTION

In a first aspect, the invention is directed to a nozzle for an injection molding apparatus, comprising a nozzle body, a heater and a first gap seal surface. The nozzle body defines a nozzle body melt passage, that is adapted to be downstream from and in fluid communication with a melt source, and upstream from and in fluid communication with a gate into a mold cavity in a mold component. The heater is thermally connected to the nozzle body for heating melt in the nozzle body melt passage. The first gap seal surface is positioned on a structure that is connected at least indirectly to the nozzle body. The first gap seal surface is adapted to be separated by a gap with respect to a second gap seal surface on the mold component. The gap is sized to inhibit the flow of melt between the first gap seal surface and the second gap seal surface.

In a second aspect, the invention is directed to an injection molding apparatus incorporating the nozzle described above.

DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings, in which:

Figure 1 is a sectional view of a portion of a nozzle in accordance with a first embodiment of the present invention;

Figure 2 is a magnified view of a sealing portion of the nozzle shown in Figure 1;

Figure 3a is a sectional view of a portion of a nozzle in accordance with a second embodiment of the present invention;

Figure 3b is a magnified view of a sealing portion of the nozzle shown in Figure 2;

Figure 3c is a sectional view of a portion of a nozzle in accordance with a third embodiment of the present invention;

Figure 4 is a sectional view of a portion of a nozzle in accordance with a fourth embodiment of the present invention;

Figure 5 is a sectional view of a portion of a nozzle in accordance with a fifth embodiment of the present invention;

Figure 6 is a sectional view of a portion of a nozzle in accordance with a sixth embodiment of the present invention;

Figure 7 is a side view of a nozzle in accordance with a seventh embodiment of the present invention;

Figure 8 is a sectional view of a portion of the nozzle shown in Figure 7;

Figure 9 is a sectional view of a portion of a nozzle in accordance with an eighth embodiment of the present invention;

Figure 10 is a sectional view of a portion of a nozzle in accordance with a ninth embodiment of the present invention;

Figure 11 is a sectional view of a portion of a nozzle in accordance with a tenth embodiment of the present invention; and

Figure 12 is a sectional view of an injection molding apparatus incorporating a nozzle in accordance with an eleventh embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is made to Figure 1, which shows a nozzle 10, in accordance with a first embodiment of the present invention. Nozzle 10 is for transferring melt from a runner in a manifold in a hot runner injection molding apparatus to a mold cavity 11 in a mold component 12. Mold cavity cooling channels 13 may optionally be included in mold component 12.

Nozzle 10 includes a nozzle body 14, a tip 16, and a heater 17 and may include a tip surrounding piece 18, an alignment piece 20 and a thermocouple 26. The nozzle body 14 has a body melt passage 28 that passes therethrough.

The heater 17 may be any suitable kind of heater, such as a resistive wire heater, or a sleeve heater, as long as it is thermally connected to the

nozzle body 14, i.e. the heater 17 is connected such that heat is transferable from the heater 17 to the nozzle body 14. For example, the heater 17 may wrap around the nozzle body 14 in a groove on the outer surface of the nozzle body 14.

The tip 16 may be removably connected to the nozzle body 14. The tip 16 defines a tip melt passage 30 therethrough that is downstream from and in fluid communication with the body melt passage 28. The tip melt passage 30 may exit from tip 16 into a chamber 32. A gate 34 transfers melt from the chamber 32 into the mold cavity 11.

Melt passes from a melt source, through one or more runners in a runner component such as a manifold, through the nozzle body melt passage 28, through the tip melt passage 30, through the chamber 32, through the gate 34 and finally into the mold cavity 11. The centre of the gate 34 defines an axis 35, which is parallel to the direction of flow of melt through gate 34, into the mold cavity 11.

The exit from the tip melt passage into the chamber 32 is shown at 36. Exit 36 may be concentric with respect to axis 35, as shown in Figure 1.

Because the melt flows through the tip 16, the tip 16 can be used to transfer heat from the heater 17 to the melt. To facilitate the heat transfer, the tip 16 is preferably made from a thermally conductive material, such as Beryllium-Copper.

Because of the melt flow through tip 16, the tip 16 may be exposed to a highly abrasive environment, and it may be desirable to make the tip 16 from a wear resistant material. An example of a material that is both thermally conductive and wear resistant is Tungsten Carbide. The tip 16 may be made in accordance with the teachings in US Patent No. 5,658,604 (Gellert et al.), which is hereby incorporated by reference and which discloses the construction of a nozzle tip using Tungsten Carbide.

The tip 16 may be positioned within a bore 37 in the nozzle body 14. Depending on the material selected for the tip 16, a threaded portion can be relatively difficult to machine. Furthermore, such a threaded portion can be brittle and subject to premature failure, depending on the material of

manufacture for the tip 16. Thus, by making the tip 16 threadless, a greater number of materials are available for its manufacture.

Furthermore, by making the tip 16 threadless, some cost of manufacture is saved for the tip 16 and correspondingly for the nozzle body 14, relative to a threaded tip.

The tip surrounding piece 18 may retain the tip 16 in place in the nozzle body 14. The tip surrounding piece 18 may include a jam surface 38 which abuts a shoulder 39 on the tip 16 to retain the tip 16 in place. The jam surface 38 and the shoulder 39 may cooperate to form a mechanical seal.

The tip surrounding piece 18 may be removably attachable to the nozzle body 14. For example, the tip surrounding piece 18 may include a tip surrounding piece threaded portion 40 for mating with a corresponding nozzle body threaded portion 41 on the nozzle body 14. The threaded portion 40 as shown in Figure 1 is an external thread, however, it is alternatively possible for the tip surrounding piece to include an internal thread to mate with an external thread on the nozzle body 14.

The tip surrounding piece 18 may also include a tool engagement portion 42, for receiving a tool (not shown), for the installation and removal of the tip surrounding piece 18 with respect to the nozzle body 14.

A gap seal 48 may be formed by the tip surrounding piece 18 in cooperation with the mold component 12, as shown more clearly in Figure 2. More specifically, a tip surrounding piece sealing surface 50 on the tip surrounding piece 18 may cooperate with a mold component sealing surface 52 on the mold component 12 to form the gap seal 48. The tip surrounding piece sealing surface 50 may be an outer surface on the tip surrounding piece 18, and the mold component sealing surface 52 may be the wall of the nozzle well, which is shown at 53 The tip surrounding piece sealing surface 50 and the mold component sealing surface 52 are separated from each other by a gap G. The tip surrounding piece sealing surface 50 may be referred to as the first gap seal surface 50, and the mold component sealing surface 52 may be referred to as the second gap seal surface 52.

Due to the viscosity of the melt in the chamber 32, the proximity of the first tip surrounding piece sealing surface 50 and the mold component sealing surface 52 inhibits melt from flowing between the first tip surrounding piece sealing surface 50 and the tip sealing surface 52. Thus, the gap G, in conjunction with the viscosity of the melt, acts as a seal.

The Gap G may be less than approximately .07 mm if it the only seal and is not combined with a mechanical seal. If the gap seal 48 is used in combination with a mechanical seal, the gap G may optimally be approximately .15 mm, or may be less than approximately .25 mm. It will be noted that the gap G required to inhibit the flow of melt is dependent on the specific molding application. The rheological properties of the melt at the injection temperature, such as its viscosity, determine the maximum gap G that provides the desired seal.

An advantage to including the gap seal 48 is that the manufacturing tolerances for sealing surfaces 50 and 52 are less demanding, relative to a typical mechanical sealing portion. A further advantage is that because melt does not pass through the gap seal 48, an air space 54 is maintained between the tip surrounding piece 18 and the mold component 12. The air space 49 provides an insulative layer to reduce heat transfer between the tip surrounding piece 18, and from the entire nozzle 10 in general, into the mold component 12.

To further reduce heat losses from the tip surrounding piece 18 and from the nozzle 10 in general into the mold component 12, the tip surrounding piece 18 may be made from a material that has a thermal conductivity that is lower than that of the material for the tip 16, depending on the specific requirements of the molding application.

The tip surrounding piece 18 may alternatively be made from a material that has a thermal conductivity that is similar to that of the nozzle tip 16. Because the tip surrounding piece 18 may be positioned between a portion of the heater 17 and the tip melt passage 30, as shown in Figure 1, it may be advantageous to make the tip surrounding piece 18 from a material that has a

thermal conductivity that is generally equal to that of the tip 16, to improve heat transfer between the heater 17 and the tip melt passage 30.

Because the melt that contacts the tip surrounding piece 18 is generally slower moving than the melt flowing through the tip 16, the tip surrounding piece 18 may be made from a material that is less wear resistant than that of the tip 16. Accordingly, the tip surrounding piece 18 may be made from a material that is relatively easily machined with threads.

Referring to Figure 1, the alignment piece 20 may be included to align the nozzle 10 with respect to the gate 34 in molding applications where such alignment is important. The alignment piece 20 may be positioned between the nozzle body 14 and a bore 56 in the mold component 12. The bore 56 includes therein, the nozzle well 53. The alignment piece 20 may be positioned between the mold component 12 and any other suitable component of the nozzle 10, instead of the nozzle body 10.

The alignment piece 20 may be made from a material that has a lower thermal conductivity than that of the nozzle portion with which it is in contact, which is in this case, the nozzle body 14. For example, the alignment piece 20 may be made from tool steel, titanium, H13, or any other suitable material. It is alternatively possible for the alignment piece 20 to be integrally formed into the nozzle body 14, or into any other suitable portion of the nozzle 10, such as the tip surrounding piece 18.

Reference is made to Figure 3a, which shows a nozzle 60 in accordance with a second embodiment of the present invention, in combination with a mold component 61.

Nozzle 60 is similar to nozzle 10 (Figure 1), and includes the nozzle body 14, the tip 16, and the heater 17, and may include a tip surrounding piece 62 and a thermocouple 26. The tip surrounding piece 62 may be similar to the tip surrounding piece 18 (Figure 1), and may have a jam surface 63 thereon which cooperates with the shoulder 39 on the tip 16 to retain the tip 16 in place in the nozzle body 14.

The tip surrounding piece 62 may include a tip surrounding piece threaded portion 64 that cooperates with the threaded portion 41 on the

nozzle body 14, so that the tip surrounding piece 62 is removably attached to the nozzle body 14.

The tip surrounding piece 62 cooperates with the mold component 61 to form a multi-portion seal 65 therebetween. The multi-portion seal 65 includes a gap seal 66 and also includes a second seal 68, which may be, for example, a mechanical seal, that is adjacent the gap seal 66. The gap seal 66 may be similar to the gap seal 48 (Figure 1), and is formed by the cooperation of a first tip surrounding piece sealing surface 70 on the tip surrounding piece 62, with a first mold component sealing surface 72 on the mold component 61. The first tip surrounding piece sealing surface 70 and the first mold component sealing surface 72 are separated by the gap G, as shown more clearly in Figure 3b. The first tip surrounding piece sealing surface 70 and the first mold component sealing surface 72 may be referred to as the first gap seal surface 70 and the second gap seal surface 72, respectively.

Because of the presence of the second seal 68, the gap G, in the embodiment shown in Figure 3a may optimally be approximately .15 mm, and may be less than approximately .25 mm.

The second seal 68 may also be referred to as a supplementary seal 68, and is formed by the cooperation of a second tip surrounding piece sealing surface 74 on the tip surrounding piece 62, with a second mold component sealing surface 76 on the mold component 61. The sealing surfaces 74 and 76 may contact each other, as shown in Figure 3a. The second tip surrounding piece sealing surface 74 and a second mold component sealing surface 76 may be referred to as the first supplementary seal surface 74 and the second supplementary seal surface 76 respectively.

The second seal 68 may be positioned behind the gap seal 66 with respect to the chamber 32, so that melt is exposed to the gap seal 66 before the second seal 68.

Because of the presence of the gap seal 66, the surface area of contact between the tip surrounding piece 62 and the mold component 61 along the sealing surfaces 74 and 76, is smaller than would be required if the

second seal 68 acted alone to seal against melt leakage therepast. Thus, the heat transfer from the tip surrounding piece 62 and from the nozzle 60 in general, into the mold component 61 is reduced accordingly.

In addition to forming the second seal 68, the second sealing surfaces 74 and 76 may cooperate to align the nozzle 10 with respect to the gate, which is shown at 78. This applies particularly in the case, as shown in Figure 3a, where the sealing surfaces 74 and 76 are substantially vertical surfaces. However, the second sealing surfaces 74 and 76 may be inclined instead of being vertical, and may still be adapted to align the nozzle 60 with respect to the gate 78.

Referring to Figure 3a, the mold component 61 may be similar to the mold component 12 (Figure 1), and defines a plurality of mold cavities 80, each of which has at least one gate 78 leading thereto. The mold component 61 may include cooling channels 82 for cooling of melt in the mold cavities 80.

Reference is made to Figure 3c, which shows a variant 60' of the embodiment shown in Figure 3a. In the nozzle 60', a tip 84 replaces the tip 16 (Figure 3a). The tip 84 may be similar to the tip 16 (Figure 3a) and may define a tip melt passage 86 therethrough. However, the tip 84 includes a torpedo portion 87, and the tip melt passage 86 may have an exit 88 that is off-centre from the axis of the gate 78, which is shown at 90.

It will be noted that the tip 84 may also replace the tip 16 in the embodiment shown in Figures 1 and 2.

Reference is made to Figure 4, which shows another variant 60" of the embodiment shown in Figure 3a. In the variant shown in Figure 4, the tip 84 replaces the tip 16 (Figure 3a). The items shown in Figure 4 are similar to those in Figure 3a, except as follows. A gap seal 66" is formed which is similar to the gap seal 66 (Figure 3a), except that the gap seal 66" is formed between a first tip surrounding piece sealing surface 70" on a tip surrounding piece 62", and a first mold component sealing surface 72" on a mold component 61". The first sealing surfaces 70" and 72" may be entirely inclined surfaces in the embodiment shown in Figure 4, whereas they are shown as including an inclined portion and a substantially vertical portion in

the embodiment shown in Figures 3a. The first sealing surfaces 70" and 72" may also be referred to as the first and second gap seal surfaces 70" and 72" respectively.

Reference is made to Figure 5, which shows yet another variant 60'" of the embodiment shown in Figure 3a. In the variant shown in Figure 5, the tip 84 replaces the tip 16 (Figure 3a). The items shown in Figure 5 are similar to those in Figure 3a, except as follows. A gap seal 66'" is formed which is similar to the gap seal 66 (Figure 3a), except that the gap seal 66'" is formed between a first tip surrounding piece sealing surface 70'" on a tip surrounding piece 62'", and a first mold component sealing surface 72'" on a mold component 61'". The first sealing surfaces 70'" and 72'" may be substantially vertical surfaces in the embodiment shown in Figure 5, whereas they are shown as including an inclined portion and a substantially vertical portion in the embodiment shown in Figures 3a. The first sealing surfaces 70'" and 72'" may also be referred to as the first and second gap seal surfaces 70'" and 72'" respectively.

Reference is made to Figure 6, in which a nozzle 100 is shown in accordance with an alternative embodiment of the present invention. The nozzle 100 may be similar to the nozzle 60 (Figure 3a), and may include a multi-portion seal 101 between a tip surrounding piece 102 and a mold component 103.

The multi-portion seal 101 includes a gap seal 104 and a second seal 105. The gap seal 101 is made by a first tip surrounding piece sealing surface 106 on the tip surrounding piece 102 cooperating with a first mold component sealing surface 107 on the mold component 103.

In this embodiment, the sealing surfaces 106 and 107 may be substantially horizontal as shown, and are separated by the gap G. The sealing surfaces 106 and 107 may also be referred to as the first and second gap seal surfaces 106 and 107 respectively. In this embodiment, a separate alignment means (not shown) may be included if desired.

It will be noted that the nozzle 100 may optionally not include the second seal 105, and have only the gap seal 101 with the mold component 103.

Reference is made to Figures 7 and 8, which show a nozzle 200. Nozzle 200 is similar to nozzle 10, but is an edge-gated nozzle. Nozzle 200 includes a nozzle body 201 having a nozzle melt passage 202, which divides into a plurality of the melt passage portions 204 (Figure 8). Nozzle 200 is for feeding melt through a plurality of gates 205 into a plurality of mold cavities 206, in a mold component 208. Nozzle 200 has an end 210, which may be positioned in a bore 212 in the mold component 208, for transferring melt into the mold cavities 206. On the end 210 is mounted a guide piece 214. The guide piece 214 fits within a guide aperture 215 for aligning the end 210 of nozzle 200 in the bore 212. The nozzle 200 may include a heater 216 and a thermocouple 218 (Figure 7).

Referring to Figure 8, each nozzle melt passage portion 204 has therewith a nozzle tip 220 and a tip surrounding piece 222. The tip 220 and the tip surrounding piece 222 may mount to the nozzle body 201, in a similar manner to tip 16 and tip surrounding piece 18 to nozzle body 14 (Figure 1). The tip 220 includes a tip melt passage 224 is in communication with a nozzle melt passage portion 204, and has an exit 226. The tip surrounding piece 222 may include a tip surrounding piece sealing surface 228 that surrounds exit 226 and gate 205, and is positioned at a gap G from a mold component sealing surface 230 on the mold component 208, forming a gap seal 232 therewith. A chamber 234 is defined between the tip 220 and the gate 205. The tip surrounding piece sealing surface 228 and the mold component sealing surface 230 may be referred to as the first and second gap seal surfaces 228 and 230 respectively.

Melt passes through nozzle melt passage 202, melt passage portions 204, tip melt passages 224, out from exits 226 into chambers 234, through gates 205 and into mold cavities 206. Melt is inhibited from escaping from chamber 234 by the gap seal 232.

Nozzle 200 may include an alternative tip 240 and tip surrounding piece 242 which are integrally joined, forming a single piece, instead of tip 220 and tip surrounding piece 222, or may include some of each type of tip and tip surrounding piece.

Reference is made to Figure 9, which shows a nozzle 300 in accordance with another embodiment of the present invention, in combination with a mold component 301. The nozzle 300 may be similar to nozzle 10 (Figure 1), and includes a nozzle body 302, the heater 17, a tip 304 and may optionally include the thermocouple 26. The nozzle body 302 defines a nozzle body melt passage 306 therethrough. The heater 17 may be positioned on the nozzle body 302 in any suitable way, for heating melt in the nozzle body melt passage 306.

The tip 304 may be similar to the tip 16 (Figure 1) and defines a tip melt passage 308 therethrough. The tip 304 may be removably connected to the nozzle body 302 in any suitable way, so that the tip melt passage 308 is in fluid communication with and downstream from the nozzle body melt passage 306. The tip 304 may, for example, have a tip threaded portion 310 for mating with a nozzle body threaded portion 312 on the nozzle body 302. The tip may further include a tip tool engagement portion 314 for receiving a tool (not shown), for the installation and removal of the tip 304 with respect to the nozzle body 302.

The mold component 301 defines a plurality of melt cavities 316, each of which has at least one gate 318 leading thereto. A plurality of cooling channels 320 may be included in the mold component 301 to cool melt in the mold cavities 316.

A gap seal 322 may be formed by the cooperation of the tip sealing surface 324 and a mold component sealing surface 326, which are separated by the gap G. The tip sealing surface 324 and the mold component sealing surface 326 may also be referred to as the first and second gap seal surfaces 324 and 326 respectively.

The tip can be manufactured by any of the materials that are used for the tip 16 (Figure 1), however, it may be advantageous to use a material other

than Tungsten Carbide, due to the existence of the threaded portion 310 on the tip 304.

Reference is made to Figure 10, which shows a nozzle 400 in accordance with another embodiment of the present invention, in combination with the mold component 301. The nozzle 400 may be similar to the nozzle 300 and includes a nozzle body 402, the heater 17, a tip 404, a tip surrounding piece 406 and may optionally include the thermocouple 26. The nozzle body 402 may be similar to the nozzle body 302 (Figure 9), and defines a nozzle body melt passage 408 therethrough. The nozzle body 402 also includes a first nozzle body threaded portion 410 for mating with a tip threaded portion 412 on the tip 404. The nozzle body 402 also includes a second nozzle body threaded portion 414 for mating with a tip surrounding piece threaded portion 416 on the tip surrounding piece 406. The tip 404 may be similar to the tip 304 and defines a melt passage 418 therethrough. The tip 404 may also include a tip tool engagement portion 420 for receiving a tool (not shown). In the embodiment shown in Figure 10, the tip 404 is removably connected to the nozzle body 402 by means of the cooperation of threaded portions 416 and 410.

The tip surrounding piece 406 may be similar to the tip surrounding piece 18 (Figure 1), except that the threaded portion 414 on the tip surrounding piece 406 may be an internally threaded portion, instead of an externally threaded portion, and except that the tip surrounding piece 406 does not retain the tip 404 in place.

The tip surrounding piece 406 may include a tip surrounding piece tool engagement portion 422 for receiving a tool (not shown).

The tip surrounding piece 406 has a tip surrounding piece sealing surface 424, which cooperates with the mold component sealing surface 326 to form a gap seal 428 therewith. The sealing surfaces 424 and 326 are separated by the gap G, which inhibits melt leakage therebetween. The sealing surfaces 424 and 326 may also be referred to as the first and second gap seal surfaces 424 and 326 respectively.

Reference is made to Figure 11, which shows a nozzle 60"", in combination with a mold component 61"", in accordance with a variant of the nozzle 60''' and mold component 61''' shown in Figure 5. The nozzle 60"" may be similar to the nozzle 60''' with the exception that a tip surrounding piece 62"" on the nozzle 60"" includes a seal piece 450 thereon. The seal piece 450 may be a band that surrounds the outer surface of the tip surrounding piece 62"", and forms a gap seal 452 with the mold component 61"". The seal piece 450 has a sealing surface before that mates with mold component sealing surface 72"" to form the gap seal 452. The sealing surfaces 454 and 72"" are separated by the gap G, which inhibits melt leakage therepast. The sealing surfaces 454 and 72"" may also referred to as the first and second gap seal surfaces 454 and 72"" respectively.

The seal piece 450 may be made from a material that has a lower thermal conductivity than that of the tip surrounding piece 62"". The seal piece 450 may, for example, be made from titanium, H13, stainless steel, mold steel or chrome steel. Other alternative materials include ceramics and plastics. The seal piece 450 may, instead of being a separate piece that is joined to the tip surrounding piece 62"", be a coating or layer that is applied to a portion of the outside surface of the tip surrounding piece 62"".

The tip surrounding piece 62"" may be positioned, at least in part, between the heater and the tip melt passage 86. It may be advantageous in the case shown in Figure 11, for the tip surrounding piece 62"" to be made from a material that is generally equally thermally conductive as the material of the tip 84. The seal piece 450 reduces the heat transfer between the tip surrounding piece 62"" and the mold component 61"", by being made from a material that has a lower thermal conductivity than that of the tip surrounding piece 62"".

Reference is made to Figure 12, which shows an injection molding apparatus 500, that includes a runner component 502, the mold component 12 and a plurality of nozzles 504 in accordance with the present invention.

The runner component 502 includes a plurality of runners 506 which transfer melt from a main runner inlet 508 to the nozzles 504. The runner component 502 may be heated by a heater 510.

The nozzles 504 transfer melt from the runner component 502 to the mold component 12. The nozzles 504 may be any of the nozzle embodiments and variants described above and shown in Figures 1-11, and include a nozzle sealing surface 512 that is separated from a mold component sealing surface 514 by the gap G to form a gap seal 516 therewith. The nozzle sealing surface 512 and the mold component sealing surface 514 may also be referred to as the first and second gap seal surfaces 512 and 514 respectively. The nozzle sealing surface 512 may be positioned on any suitable portion or component of the nozzle 504.

A particular example of an injection molding apparatus is shown in Figure 12. It will be appreciated that the injection molding apparatus that incorporates the gap seal of the present invention may be any suitable type of injection molding apparatus and is not limited to the example shown.

It will be appreciated that the first and second gap seal surfaces that make up the gap seal of the present invention, may be surfaces on any component of the nozzle and mold component respectively, and are not limited to the examples shown and described herein. For greater certainty, the first gap seal surface may be positioned on any suitable structure that is part of the nozzle, and is therefore connected at least indirectly to the nozzle body.

Thermal expansion and contraction during a molding cycle must be considered during the construction of the nozzles described above, so that the gap G is within the ranges given above when the nozzle feeds melt into the gate.

It will be appreciated that it may be advantageous to size the gap G so as to reduce to a desired level, the amount of heat lost from the nozzle.

It will be appreciated that the particular configuration of the gap seal portion may be selected depending on the specific molding application, including the rheological properties of the melt, such as its viscosity at the

injection temperature. It is contemplated that the invention can be applied to nozzles with types of melt other than those types of melt specifically disclosed herein.

While the above description constitutes the preferred embodiments, it will be appreciated that the present invention is susceptible to modification and change without departing from the fair meaning of the accompanying claims.

CLAIMS

1. A nozzle for an injection molding apparatus, comprising:

a nozzle body, said nozzle body defining a nozzle body melt passage, wherein said nozzle body melt passage is adapted to be downstream from and in fluid communication with a melt source, and said nozzle body melt passage is adapted to be upstream from and in fluid communication with a gate into a mold cavity in a mold component;

a heater that is thermally connected to said nozzle body for heating melt in said nozzle body melt passage; and

a first gap seal surface positioned on a structure that is connected at least indirectly to said nozzle body, wherein said first gap seal surface is adapted to be separated by a gap with respect to a second gap seal surface on the mold component, wherein said gap is sized to inhibit the flow of melt between said first gap seal surface and said second gap seal surface.

2. A nozzle as claimed in claim 1, wherein said gap is sized in relation to the temperature of the melt, and the viscosity of the melt intended to flow through the nozzle.

3. A nozzle as claimed in claim 1, wherein, when said first gap seal surface and said second gap seal surface are separated by said gap, an air space is defined between said first gap seal surface and said second gap seal surface, and said air space is adapted to insulate said nozzle against heat loss.

4. A nozzle as claimed in claim 1, further comprising a first supplementary seal surface positioned on a structure that is connected at least indirectly to said nozzle body, wherein said first supplementary seal surface is positioned adjacent said first gap seal surface and is adapted to cooperate with a second supplementary seal surface on the mold component to form a supplementary seal in addition to said gap seal.

5. A nozzle as claimed in claim 1, further comprising a tip, said tip defining a tip melt passage that is downstream from and in communication with said nozzle body melt passage, and said tip melt passage is upstream from said gate.

6. A nozzle as claimed in claim 5, wherein said first gap seal surface is positioned on said tip.

7. A nozzle as claimed in claim 5, further comprising a tip surrounding piece, wherein said tip surrounding piece is adapted to be positioned closer to said mold component than said tip.

8. A nozzle as claimed in claim 7, wherein said first gap seal surface is positioned on said tip surrounding piece.

9. A nozzle as claimed in claim 7, further comprising a seal piece positioned on said tip surrounding piece, wherein said first gap seal surface is positioned on said seal piece.

10. A nozzle as claimed in claim 7, wherein said tip surrounding piece retains said tip in place.

11. A nozzle as claimed in claim 7, wherein said tip surrounding piece is removably connected with respect to said nozzle body.

12. A nozzle as claimed in claim 5, wherein said tip is removably connected with respect to said nozzle body.

13. A nozzle as claimed in claim 7, wherein said tip is removably connected with respect to said nozzle body.

14. A nozzle as claimed in claim 1, further comprising an alignment piece that is connected at least indirectly to said nozzle body and is adapted to align said nozzle with respect to said gate.

15. A nozzle as claimed in claim 14, wherein the material of said alignment piece has a lower thermal conductivity than the thermal conductivity of the material of the component of the nozzle with which said alignment piece is in contact.

16. A nozzle as claimed in claim 7, wherein said tip surrounding piece is made from a material that is less thermally conductive than the material of said tip.

17. A nozzle as claimed in claim 7, wherein said tip surrounding piece is made from a material that has a thermal conductivity that is generally similar to the thermal conductivity of said tip.

18. A nozzle as claimed in claim 9, wherein the material of said seal piece has a thermal conductivity that is lower than the thermal conductivity of the material of said tip surrounding piece.

19. A nozzle as claimed in claim 7, wherein said tip surrounding piece is adapted to cooperate with said mold component to align said nozzle with respect to said gate.

20. A nozzle as claimed in claim 1, wherein said gap is less than approximately .07 mm.

21. A nozzle as claimed in claim 4, wherein said gap is approximately .15 mm.

22. A nozzle as claimed in claim 4, wherein said gap is less than approximately .25 mm.

23. An injection molding apparatus, comprising:

a mold component and at least one nozzle;

wherein said at least one nozzle includes a nozzle body, said nozzle body defining a nozzle body melt passage, wherein said nozzle body melt passage is adapted to be downstream from and in fluid communication with a melt source, and said nozzle body melt passage is adapted to be upstream from and in fluid communication with a gate into a mold cavity in a mold component,

wherein said at least one nozzle includes a heater that is thermally connected to said nozzle body for heating melt in said nozzle body melt passage,

wherein said at least one nozzle includes a first gap seal surface positioned on a structure that is connected at least indirectly to said nozzle body,

wherein said mold component defines a mold cavity and a gate into said mold cavity,

wherein said mold component includes a second gap seal surface thereon, and

wherein said first gap seal surface is separated by a gap with respect to said second gap seal surface, wherein said gap is sized to inhibit the flow of melt between said first gap seal surface and said second gap seal surface.

24. A nozzle as claimed in claim 23, wherein said gap is sized in relation to the temperature of the melt, and the viscosity of the melt intended to flow through the nozzle.

25. A nozzle as claimed in claim 23, wherein, when said first gap seal surface and said second gap seal surface are separated by said gap, an air space is defined between said first gap seal surface and said second gap seal

surface, and said air space is adapted to insulate said nozzle against heat loss.

26. A nozzle as claimed in claim 23, further comprising a first supplementary seal surface positioned on a structure that is connected at least indirectly to said nozzle body, and a second supplementary seal surface positioned on said mold component, wherein said first supplementary seal surface is positioned adjacent said first gap seal surface and is adapted to cooperate with said second supplementary seal surface to form a supplementary seal in addition to said gap seal.

27. A nozzle as claimed in claim 23, further comprising a tip, said tip defining a tip melt passage that is downstream from and in communication with said nozzle body melt passage, and said tip melt passage is upstream from said gate.

28. A nozzle as claimed in claim 27, wherein said first gap seal surface is positioned on said tip.

29. A nozzle as claimed in claim 27, further comprising a tip surrounding piece, wherein said tip surrounding piece is adapted to be positioned closer to said mold component than said tip.

30. A nozzle as claimed in claim 29, wherein said first gap seal surface is positioned on said tip surrounding piece.

31. A nozzle as claimed in claim 29, further comprising a seal piece positioned on said tip surrounding piece, wherein said first gap seal surface is positioned on said seal piece.

32. A nozzle as claimed in claim 29, wherein said tip surrounding piece retains said tip in place.

33. A nozzle as claimed in claim 29, wherein said tip surrounding piece is removably connected with respect to said nozzle body.

34. A nozzle as claimed in claim 27, wherein said tip is removably connected with respect to said nozzle body.

35. A nozzle as claimed in claim 29, wherein said tip is removably connected with respect to said nozzle body.

36. A nozzle as claimed in claim 23, further comprising an alignment piece that is connected at least indirectly to said nozzle body and is adapted to align said nozzle with respect to said gate.

37. A nozzle as claimed in claim 36, wherein the material of said alignment piece has a lower thermal conductivity than the thermal conductivity of the material of the component of the nozzle with which said alignment piece is in contact.

38. A nozzle as claimed in claim 29, wherein said tip surrounding piece is made from a material that is less thermally conductive than the material of said tip.

39. A nozzle as claimed in claim 29, wherein said tip surrounding piece is made from a material that has a thermal conductivity that is generally similar to the thermal conductivity of said tip.

40. A nozzle as claimed in claim 31, wherein the material of said seal piece has a thermal conductivity that is lower than the thermal conductivity of the material of said tip surrounding piece.

41. A nozzle as claimed in claim 29, wherein said tip surrounding piece is adapted to cooperate with said mold component to align said nozzle with respect to said gate.

42. A nozzle as claimed in claim 23, wherein said gap is less than approximately .07 mm.

43. A nozzle as claimed in claim 26, wherein said gap is approximately .15 mm.

44. A nozzle as claimed in claim 26, wherein said gap is less than approximately .25 mm.

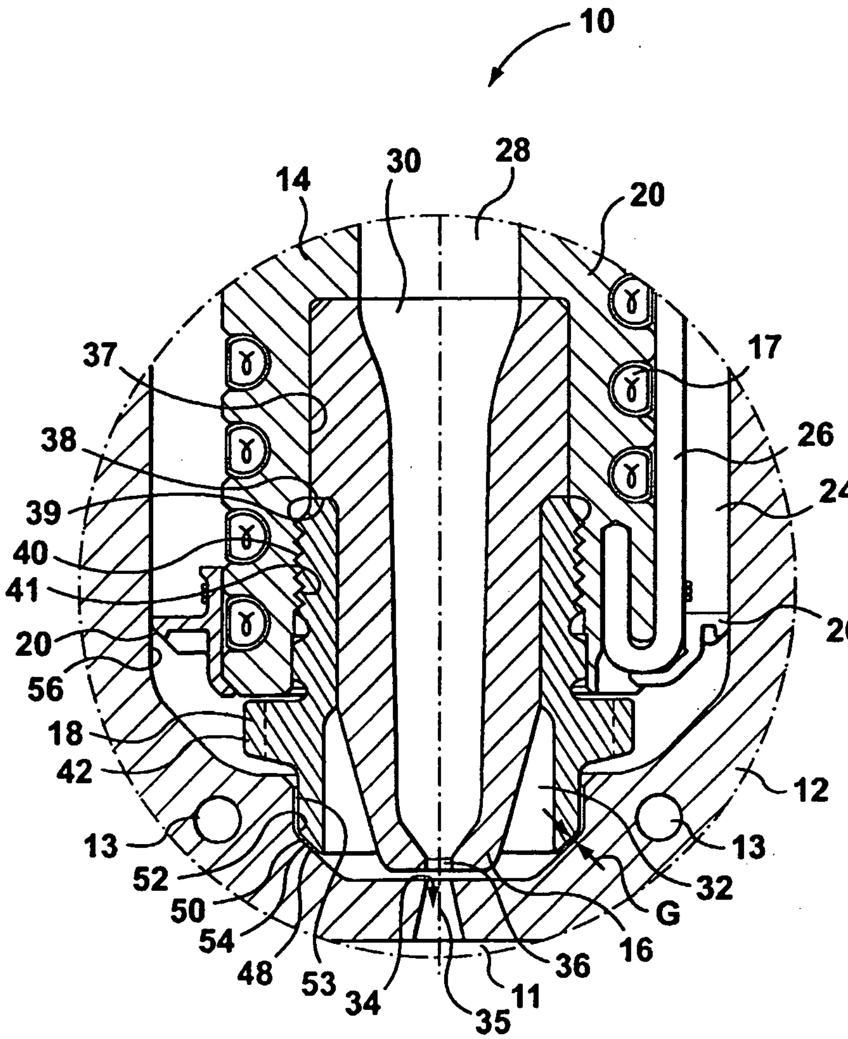
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FIG. 1

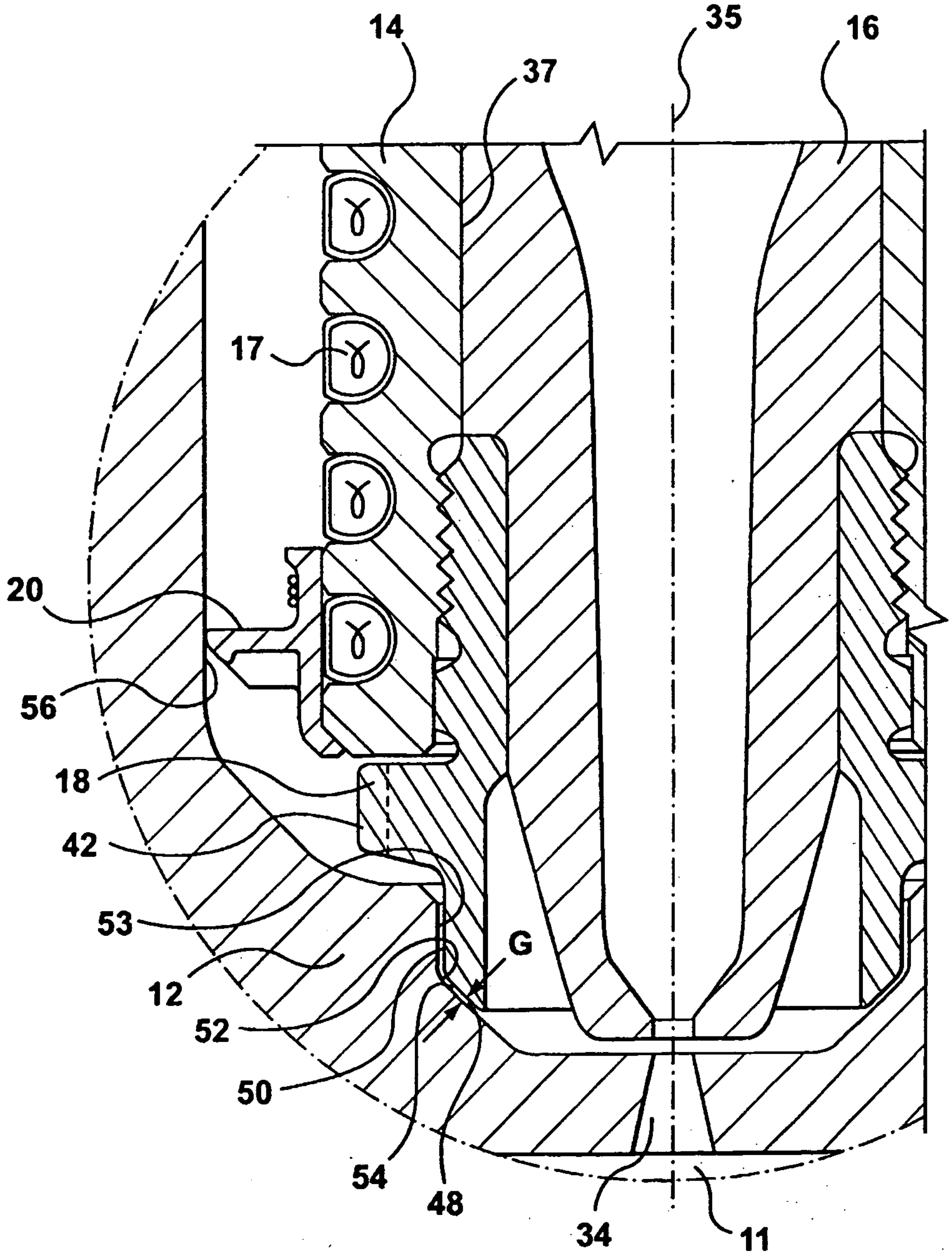

FIG. 2

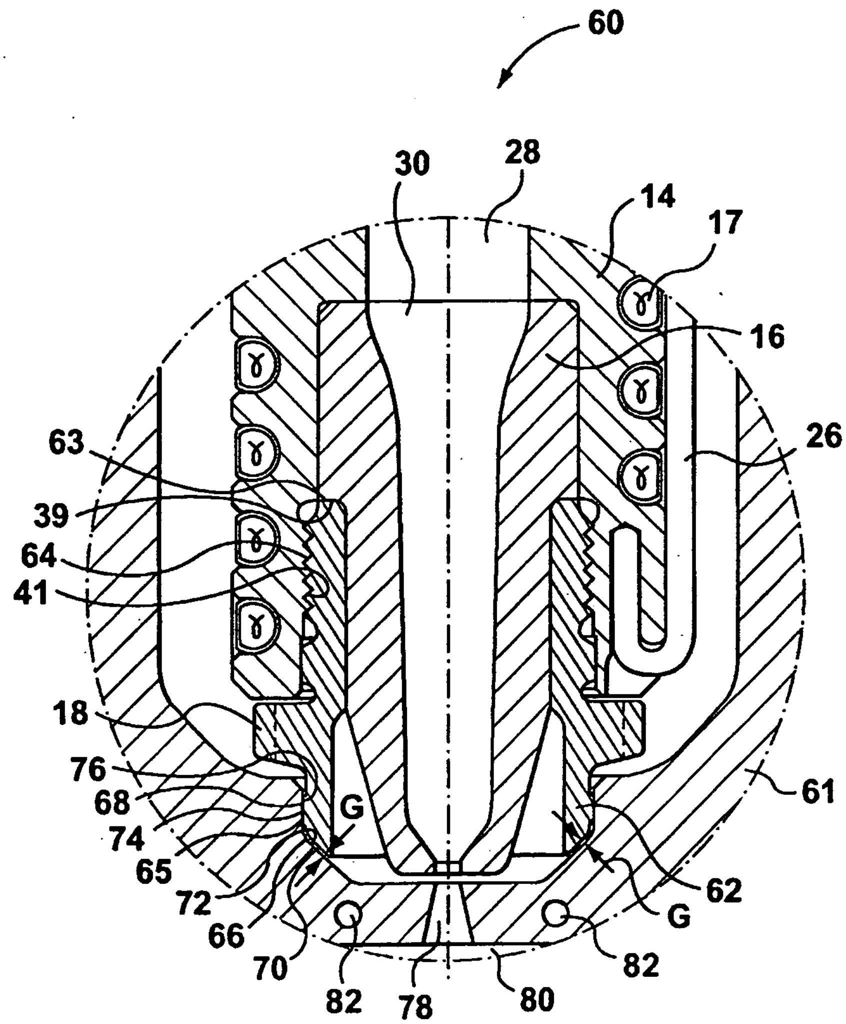
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FIG. 3a

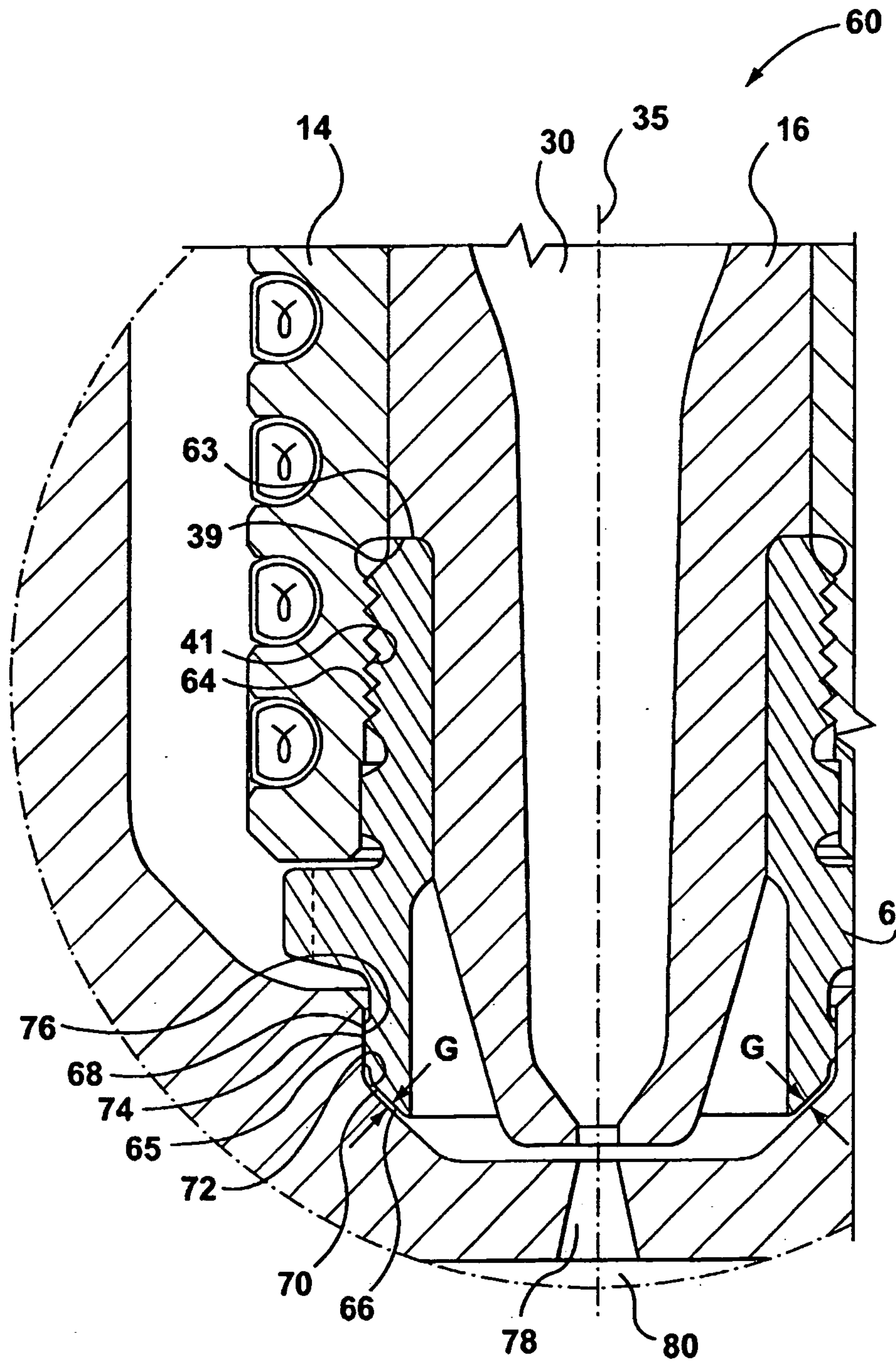

FIG. 3b

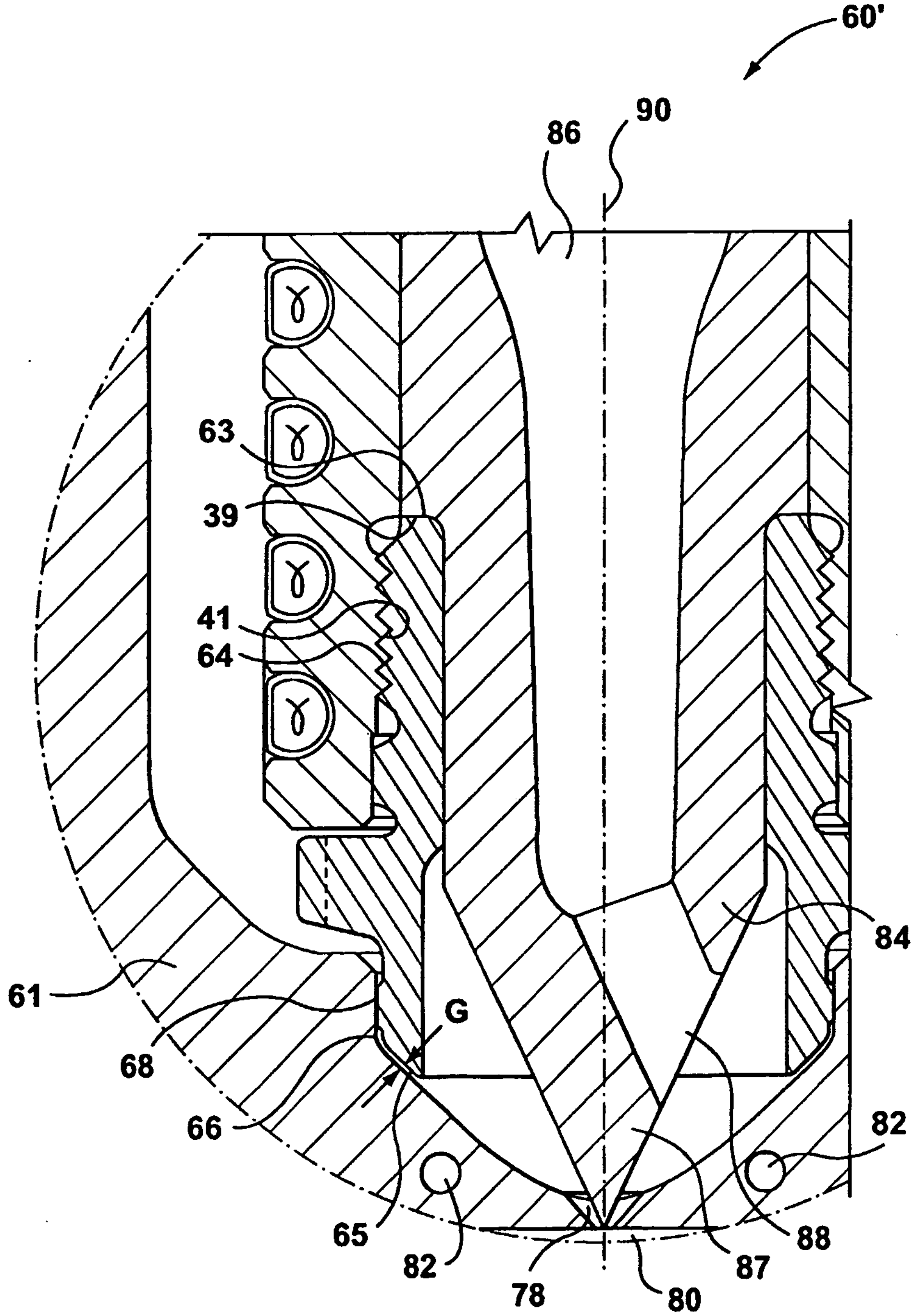

FIG. 3c

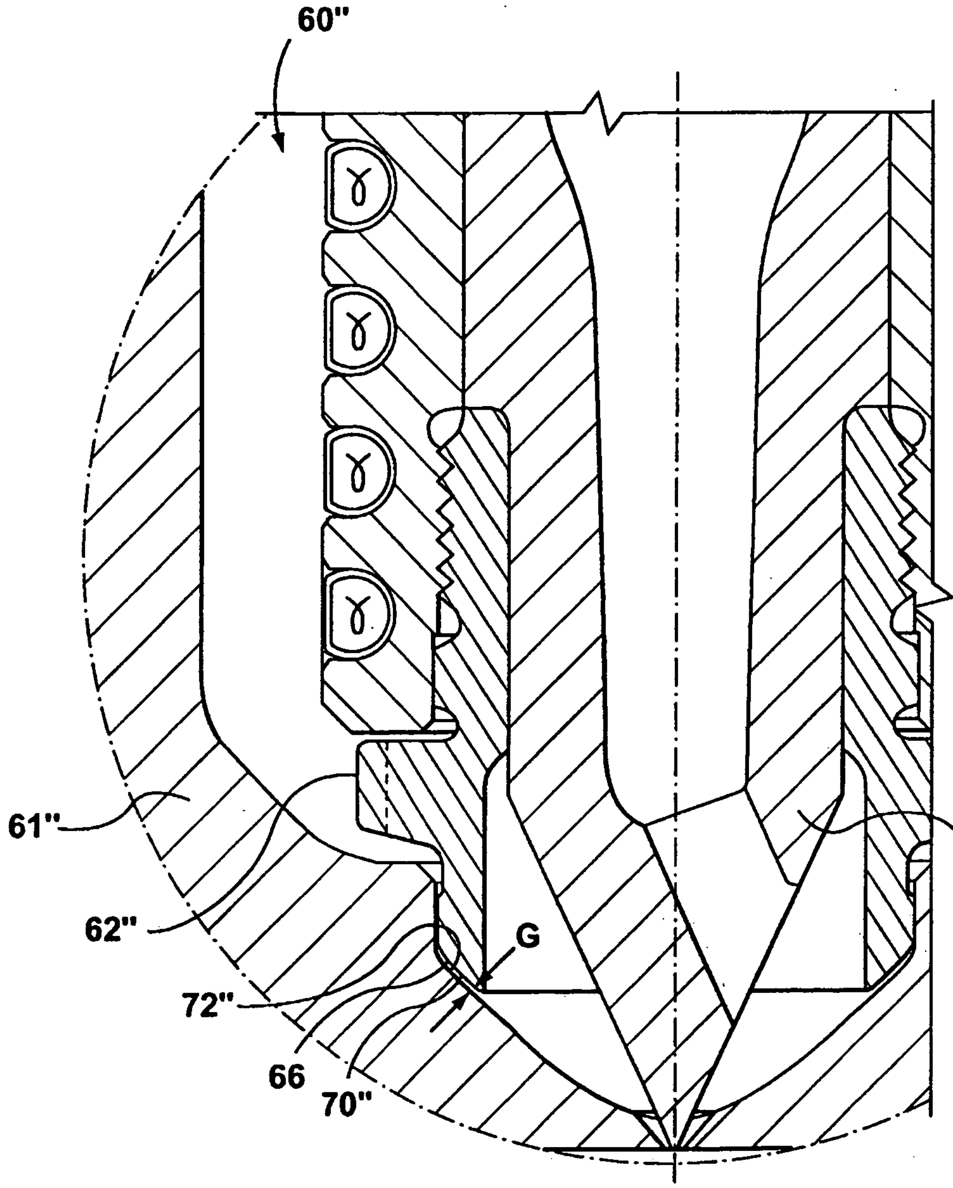

FIG. 4

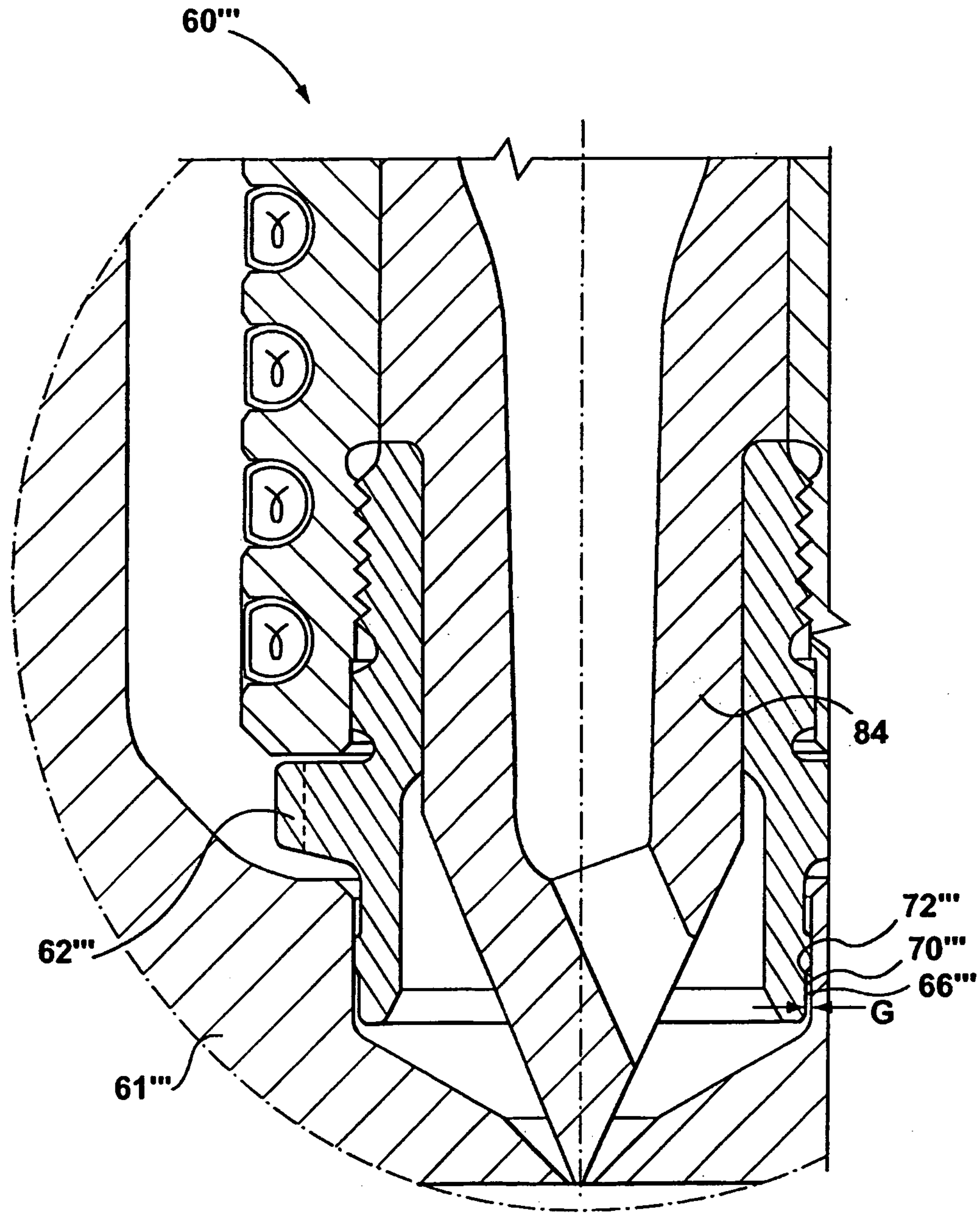

FIG. 5

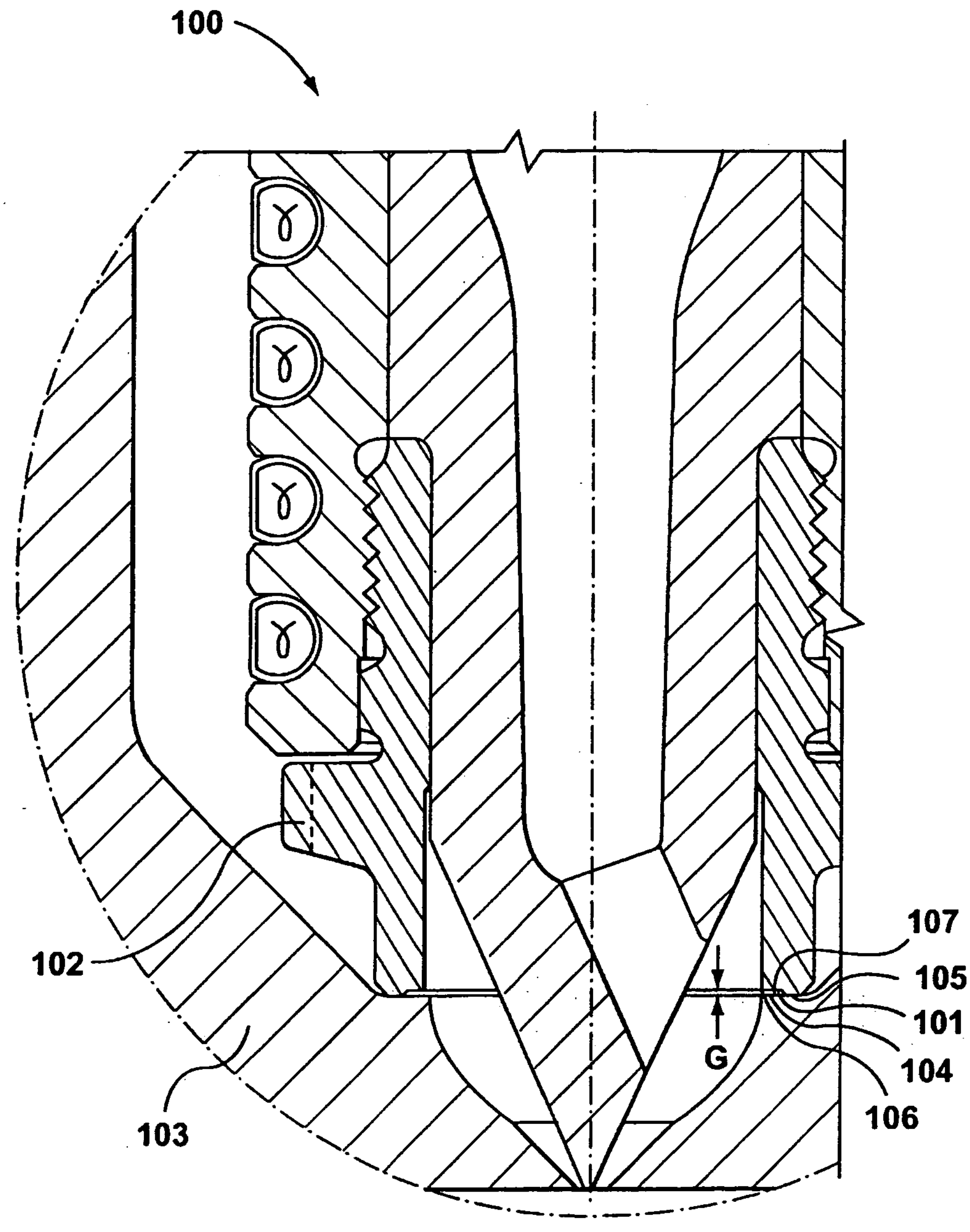

FIG. 6

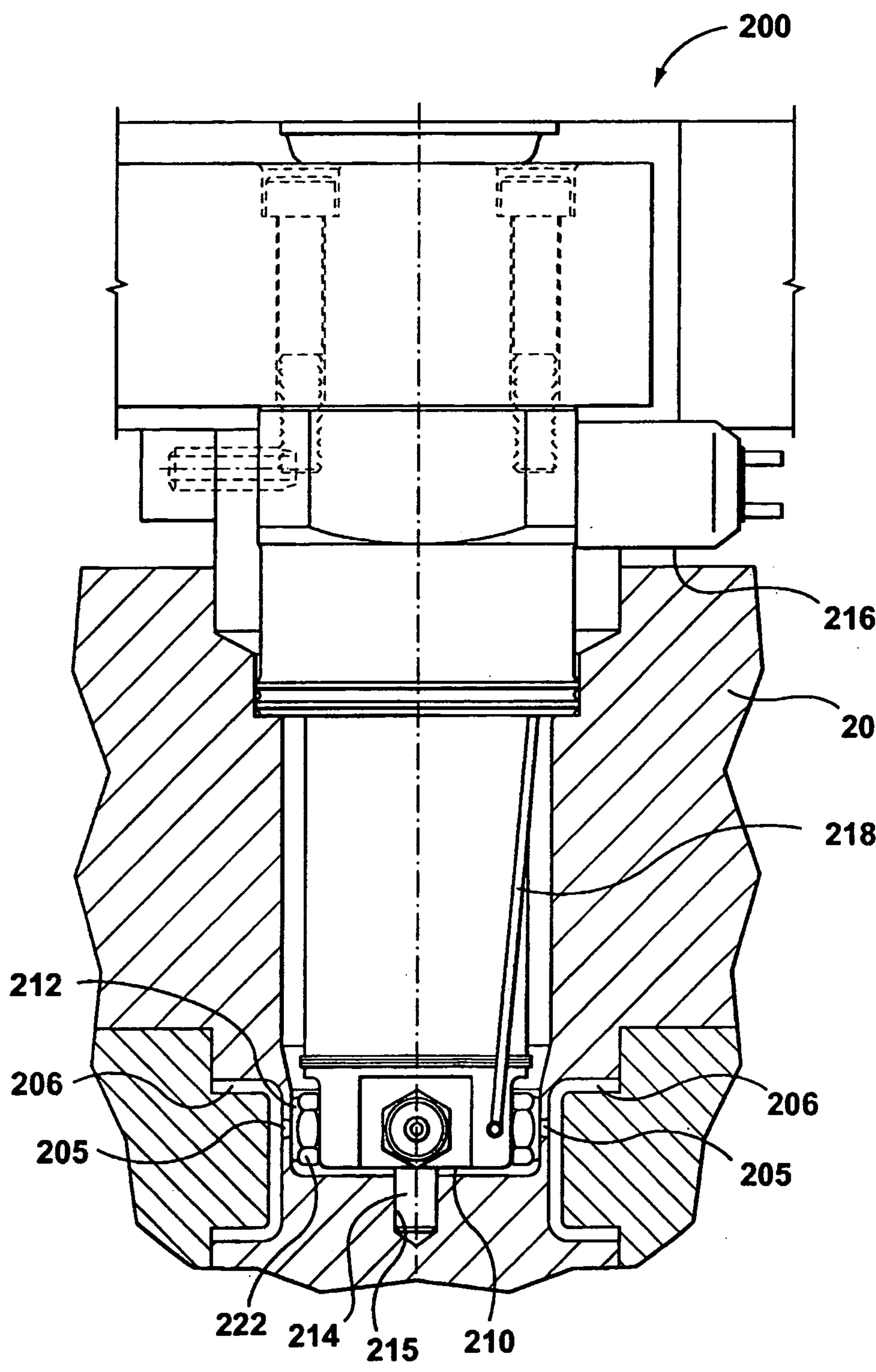

FIG. 7

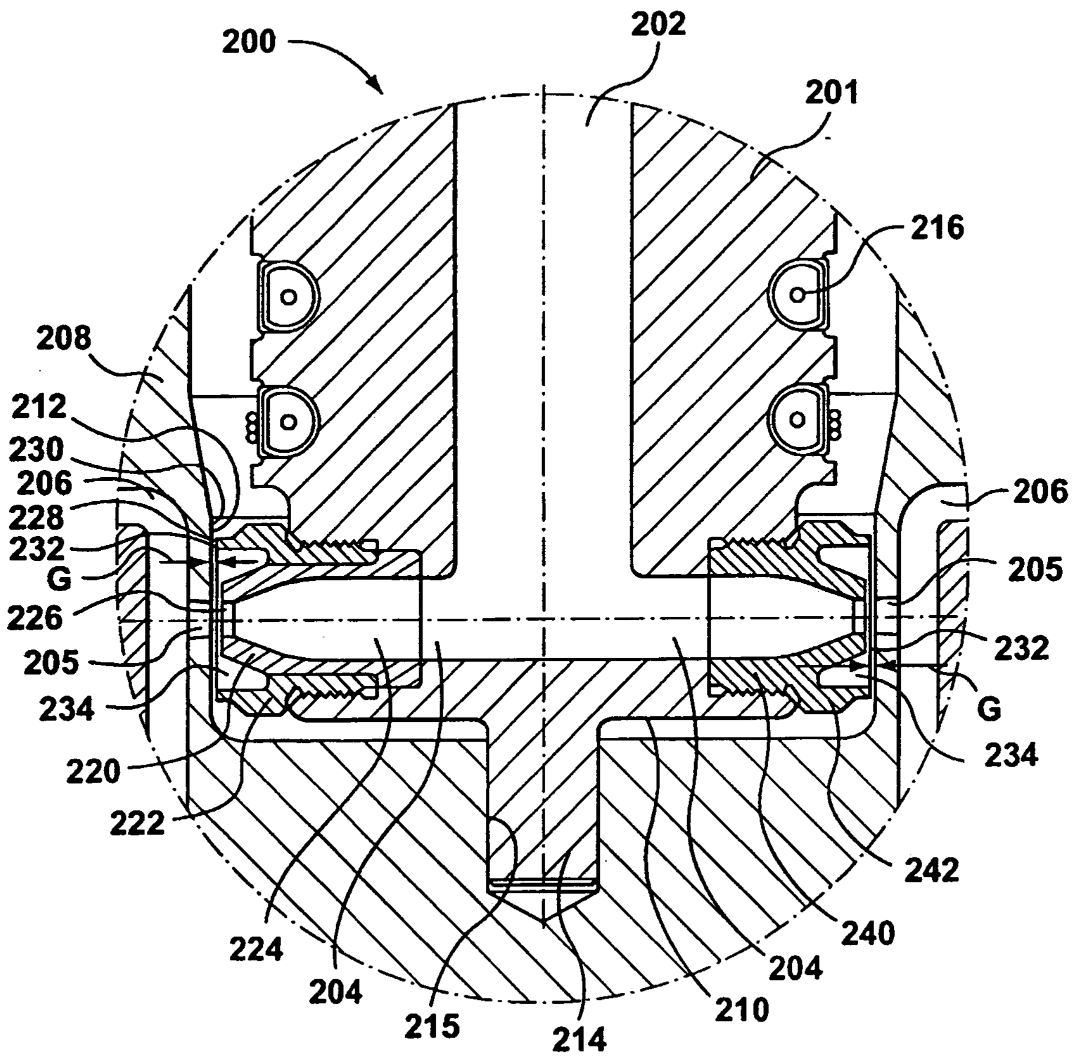
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FIG. 8

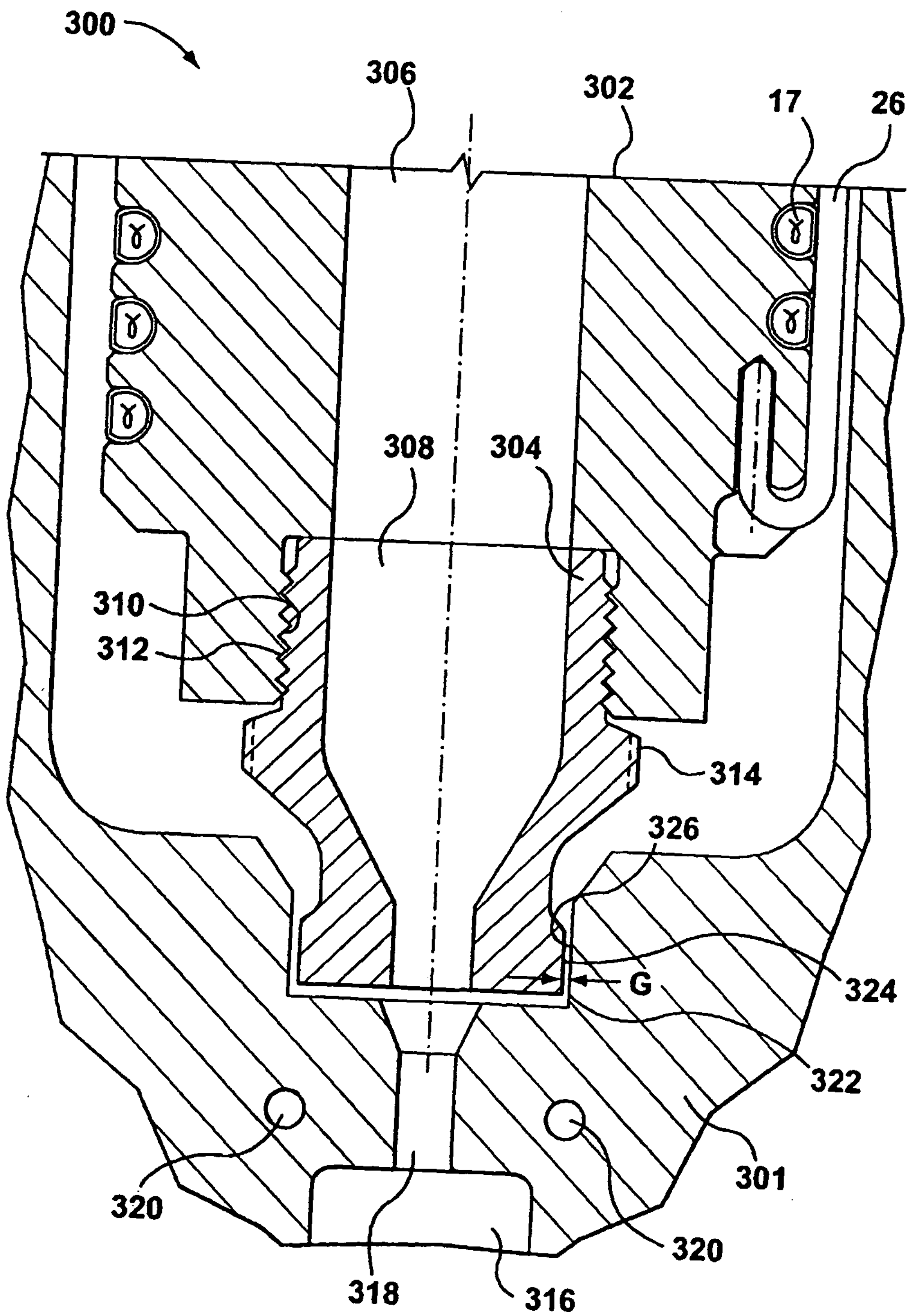
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FIG. 9

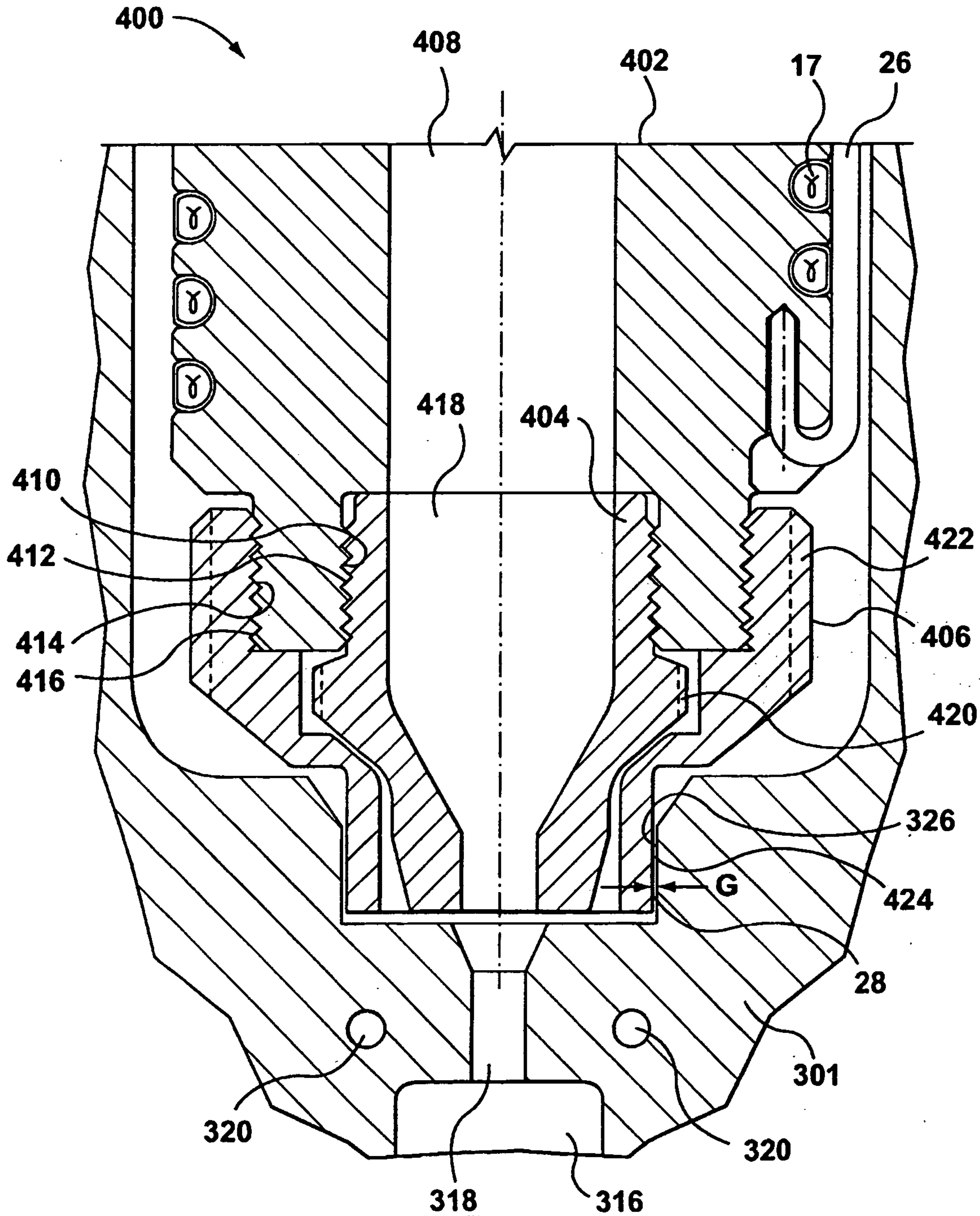
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FIG. 10

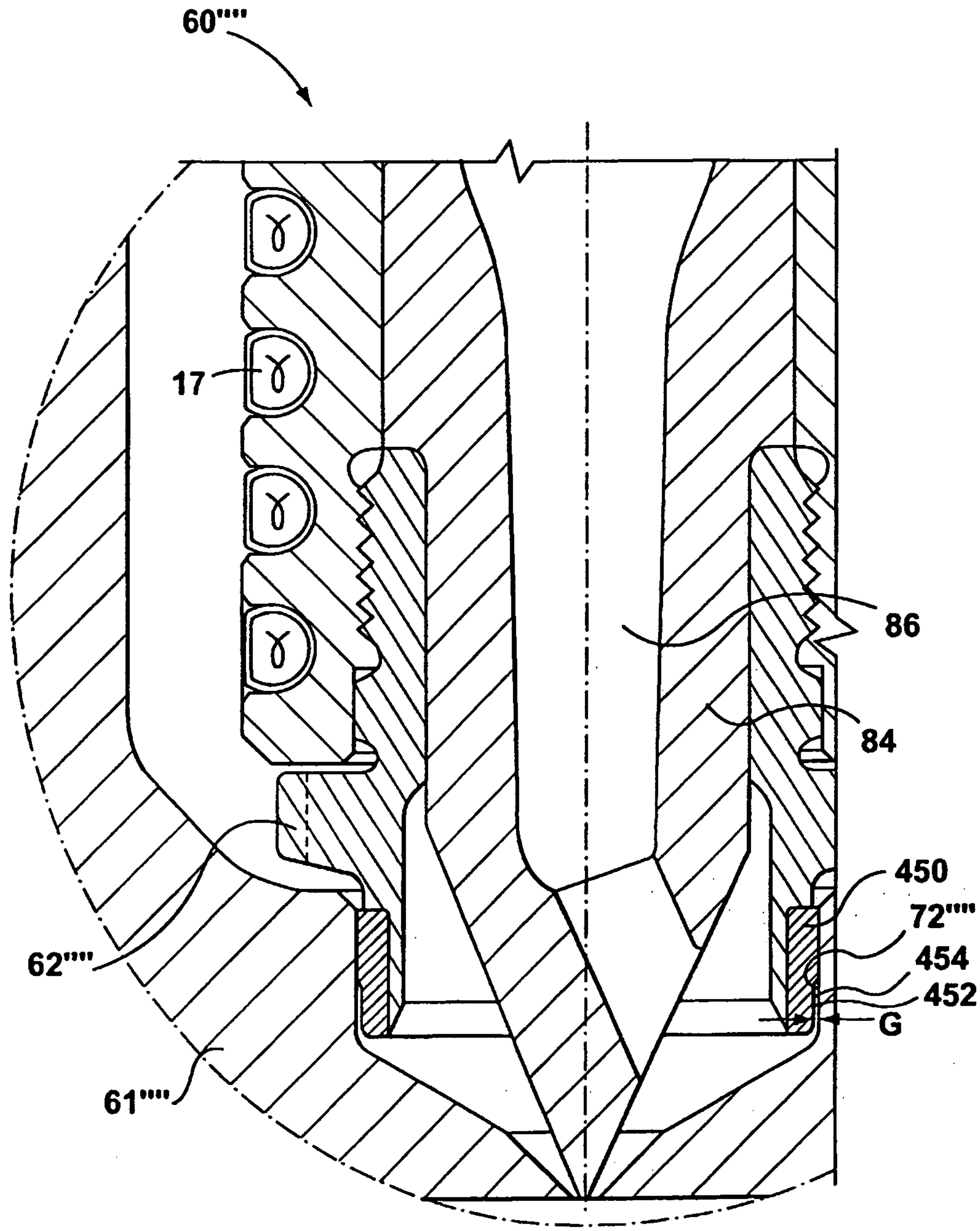

FIG. 11

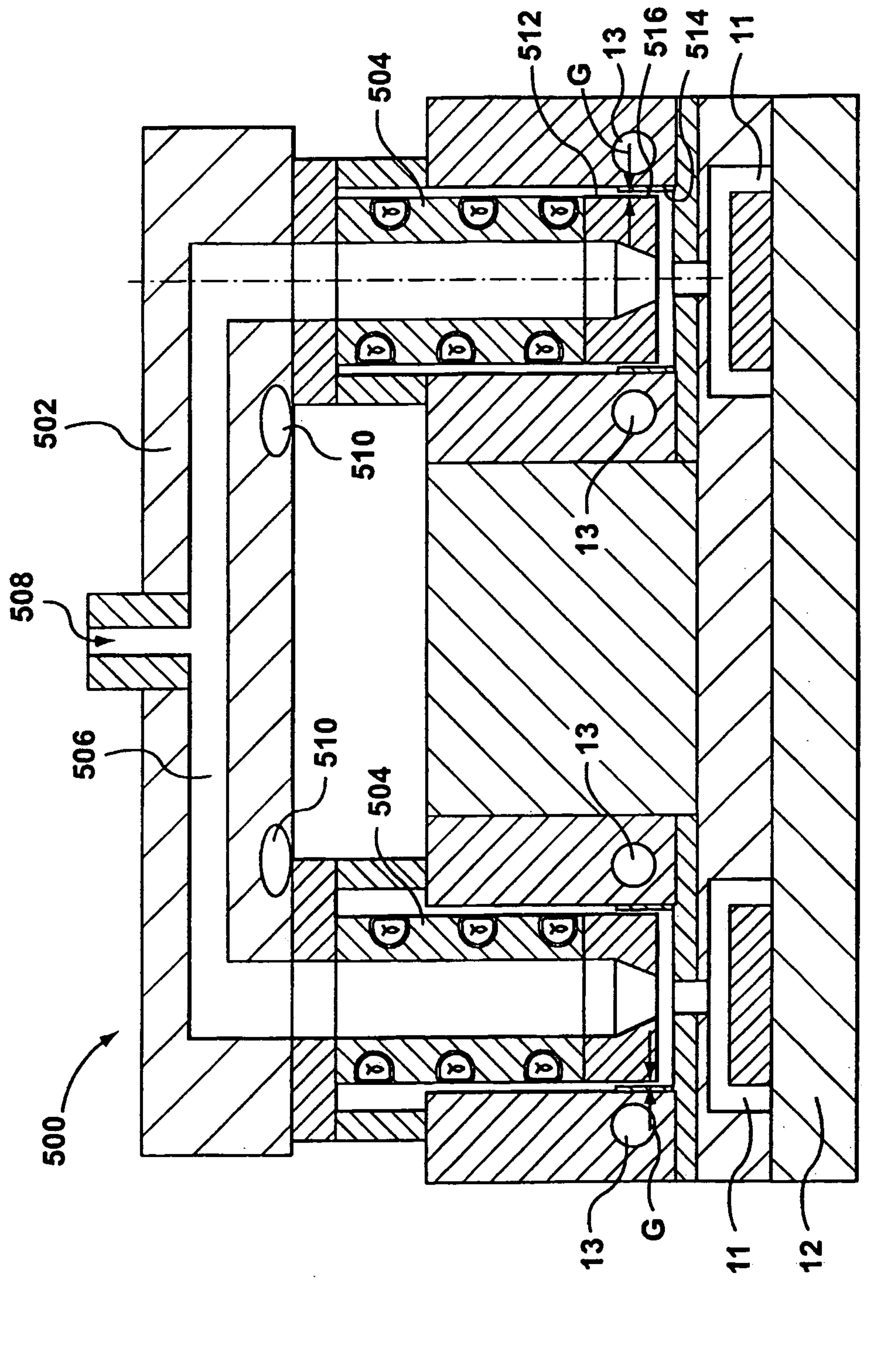

FIG. 12

INTERNATIONAL SEARCH REPORT

WO 03/028973

International Application No
PCT/CA02/01483
PCT/CA 02/01483

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C45/27

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 820 899 A (GELLERT JOBST ULRICH ET AL) 13 October 1998 (1998-10-13) column 1, line 22 column 3, line 43 - line 56	1-44
A	GB 1 540 698 A (GELLERT J) 14 February 1979 (1979-02-14) page 3, line 43 - line 47	1-44
A	ROBINSON J D ET AL: "GATING AND COOLING TECHNIQUES FOR POLYPROPYLENE" , PLASTICS, XX, XX, PAGE(S) 47-51 XP002003238 figure 18	1-44
A	US 6 287 107 B1 (MOSS MARK D ET AL) 11 September 2001 (2001-09-11) column 8, line 1 - line 22; figure 5C	1-44

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 December 2002	09/01/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kujat, C

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 590 677 A (HUSKY INJECTION MOLDING) 6 April 1994 (1994-04-06) figure 3 -----	1-44

INTERNATIONAL SEARCH REPORT

WO 03/028973

Information on patent family members

International Application No
PCT/CA02/01483
PCT/CA 02/01483

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5820899	A	13-10-1998	NONE			
GB 1540698	A	14-02-1979	US	4053271	A	11-10-1977
			CA	1032318	A1	06-06-1978
US 6287107	B1	11-09-2001	US	6419870	B1	16-07-2002
			US	6294122	B1	25-09-2001
			US	6361300	B1	26-03-2002
			US	6062840	A	16-05-2000
			AU	1248801	A	06-06-2001
			EP	1242227	A2	25-09-2002
			WO	0134364	A2	17-05-2001
			US	2002164392	A1	07-11-2002
			US	2002121713	A1	05-09-2002
			US	2002132025	A1	19-09-2002
			US	6309208	B1	30-10-2001
			EP	0967063	A1	29-12-1999
			CA	2329706	A1	28-10-1999
			EP	1073551	A1	07-02-2001
			JP	2002513687	T	14-05-2002
			WO	9954109	A1	28-10-1999
			US	6464909	B1	15-10-2002
			US	6343921	B1	05-02-2002
			US	6343922	B1	05-02-2002
			US	6254377	B1	03-07-2001
			US	6436320	B1	20-08-2002
			CA	2246771	A1	02-03-1999
			EP	0901896	A2	17-03-1999
			US	6261075	B1	17-07-2001
EP 0590677	A	06-04-1994	US	5324191	A	28-06-1994
			AT	153902	T	15-06-1997
			DE	69311247	D1	10-07-1997
			DE	69311247	T2	16-10-1997
			DK	590677	T3	07-07-1997
			EP	0590677	A1	06-04-1994
			ES	2103411	T3	16-09-1997
			GR	3023792	T3	30-09-1997
			JP	2032429	C	19-03-1996
			JP	6210668	A	02-08-1994
			JP	7071811	B	02-08-1995